DOCUMENT RESUME

ED 336 344 SP 033 165

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TITLE An Experienced Teacher's Emerging Constructivist Beliefs about Teaching and Learning.
PUB DATE Apr 91
NOTE 23p.; Paper presented at the Annual Meeting of the American Educational Research Association (Chicago, IL, April 3-7, 1991).
PUB TYPE Speeches/Conference Papers (150) -- Reports - Research/Technical (143)

EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS *Attitude Change; Case Studies; High Schools; Inservice Teacher Education; Longitudinal Studies; *Staff Development; *Teacher Attitudes; Teaching Experience; *Teaching Methods
IDENTIFIERS Concept Maps; *Constructivist Thinking; Semantic Mapping; Taba (Hilda) Teaching Strategies

ABSTRACT

This study focuses on a teacher's process of changing; specifically, the changes in her beliefs throughout her participation in and at the conclusion of a particular staff development project. The staff development classes were designed for the staff developer to model the Hilda Taba Teaching Strategies to introduce key concepts of cognitive science and constructivist notions of learning. Comparisons of semantic maps of the teacher's initial and final interviews showed distinct similarities and differences in her beliefs about learning and teaching. Semantic maps of the teacher's intermediate interviews were analyzed to examine changes in belief throughout the staff development project. Findings from this study indicate that changes in practice and beliefs occur throughout the staff development process and that these changes represent interactive processes rather than causal ones. Results suggest the need for constructivist research designs when seeking to identify and change teachers' core beliefs. Results also suggest a need for constructivist staff development projects that address the teacher as a learner and that involve the teacher in praxis--doing, reflecting, learning, changing. Ninety-five references are listed. (IAH)

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An Experienced Teacher's Emerging Constructivist Beliefs About Teaching and Learning

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A paper presented in V. Richardson and K. Tobin (Chairs),
The emerging role of constructivism in changes in teachers' beliefs.
Symposium conducted at the conference of the American Educational Research Association,
Chicago, IL, April 1991.

ED338444

Each year, school districts invest between $1,000 and $1,700 per teacher on staff development to change existing educational practices or implement new ones (Moore & Hyde, 1981; Rutherford, 1989). Over the last three decades, the changes expected in return for these expenditures required the implementation of federally mandated programs, curriculum innovations, and teaching models. Each of these change efforts represents the focus of educational reform during the last three decades, and the problems inherent in their implementation forecast the incessant recurrence of educational reforms that have occurred over the last century (Cuban, 1990).

Early analyses of the school reforms of the 1960s and 1970s provided a wealth of "teacher-proof" prescriptions for implementing change but little evidence that actual changes in practice had occurred (Deal & Derr, 1980; Doyle & Ponder, 1977; Fenstermacher & Berliner, 1985; Goodlad, 1984; McLaughlin, 1987; Smylie, 1988). Some educational researchers attempted to explain the failure to implement these reforms as functions of the organizations and economics (Elmore, 1983; Popkewitz, 1978; Popkewitz & Lind, 1989; Yin, 1981), other researchers focused on the assumptions and beliefs implicit in these change efforts (Deal & Derr, 1980; Fuller & Izu, 1986; Lauter, 1968), and other researchers examined the attitudes, values, and beliefs of teachers responsible for implementing the changes (Guskey, 1985, 1986; Lieberman & Miller, 1984; McLaughlin, 1987; McLaughlin & Marsh, 1978). Yet, other researchers sought explanations related to the complex culture of schools (Goodlad & Klein, 1970; Heckman, 1987; Sarason, 1971) and the complex context or ecology of change (Doyle & Ponder, 1977; Fullan, 1982; Griffin, 1983a; Lieberman & Miller, 1978, 1984; Wildman & Niles, 1987). In response to the complex environments in which changes were implemented, teachers modified their practices to conform to both project requirements and school and classroom realities (Doyle & Ponder, 1977). The implemented strategies became mutual adaptations of the intended changes (Berman & McLaughlin, 1976; McLaughlin & Marsh, 1978). Thus, research and theory regarding the failure to implement policy and its concomitant changes in practice shifted from a focus on institutional factors impacting change to individual characteristics of the teachers involved in implementing change and the complex ecology in which these changes take place (Doyle & Ponder, 1977; McLaughlin, 1987).

More recent research about teachers' beliefs and those implicit in the design of the teaching strategies or curriculum supported the notion that mutual adaptation may be a function of the contrast between the teacher's personal beliefs about teaching and learning and those implicit in the innovation (Anning, 1988; Au, 1990; Johnston, 1988; Munby, 1982, 1984; Olson, 1980; 1981; Taylor, 1990; Tobin, 1990; Ulerick & Tobin, 1990). Olson (1981) examined the relationship between eight teachers' beliefs and their implementation of a new science curriculum. The subjects of this study held beliefs about teaching and learning that were antithetical to the inquiry-based curriculum they were implementing. That is, the subjects held beliefs about teaching and learning that placed the teacher in the role of disseminator of knowledge and the student in the role of receiver of information. While trying to implement inquiry-based instruction, the subjects were resistant to asking open-ended questions and relying upon students' discovering relationships and continued to ask closed-ended questions and to tell students what they were supposed to find. Anning (1988), Au (1990), Johnston (1988), Taylor (1990), and Tobin (1990) reported similar mutual adaptations in their research studies about curriculum implementation.

Most school reforms require the implementation of policies and procedures; therefore, staff development has flourished as a means to introduce and reinforce required school, classroom, and teacher changes (Shroyer, 1990). During the first half of the 1980s, the federal government invested more than $2 billion each year on staff development projects to implement policies or practices in local schools (Fenstermacher & Berliner, 1985); however, despite this annual investment, research regarding the impact of staff development on school, classroom, and teacher change has been inconclusive and scant (Doyle & Ponder, 1977; Fullan, 1985; Griffin, 1983a, 1983b; Guskey, 1986; Joyce, Showers & Rolheiser-Bennett, 1987; McLaughlin, 1987; Smylie, 1988). The only federal

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program with longitudinal, researched records of success are those related to Public Law 94-142 (Sarason, 1971; 1990). Nevertheless, school districts continue to invest in staff development to change existing educational practices or implement new ones. Although change is difficult within complex school ecologies (Doyle & Ponder, 1977; Fullan, 1982, 1985) and perhaps impossible or improbable within the thoroughly embedded culture of schools (Sarason, 1971, 1990), Richardson (1990) reminded us that change occurs in schools all the time: teachers learn to become teachers; teachers learn new practices. And, if we define learning as a way of changing (Lester & Onore, 1990), change occurs more frequently and successfully than we realize.

Because of the difficulties inherent in the complex contexts of schools, few researchers have attempted to unravel the process through which change takes place in schools (Doyle & Ponder, 1977; Fullan, 1985; Griffin, 1983a). Based on an analysis of several research studies and his professional and personal experiences involving staff development, Guskey (1985, 1986) proposed a model of change to explain and inform staff development. Because the subjects in several studies expressed changed beliefs after they had implemented innovations and had recognized positive effects on student learning, Guskey (1985, 1986) concluded that there is a linear, temporal relationship among implementation, students' achievement, and teachers' beliefs and attitudes. First, teachers participate in staff development. Second, teachers make changes in classroom practices. Third, the innovation enhances the learning outcomes of the students. Last, teachers change attitudes and beliefs. Guskey (1986) explained that the process is more complex than his model implies, yet he described the change process as follows:

> According to the model, when teachers see that a new program or innovation enhances the learning outcomes of students in their classes; when, for example, they see their students attaining higher levels of achievement, becoming more involved in instruction, or expressing greater confidence in themselves or their ability to learn, then, and perhaps only then, is significant change in their beliefs and attitudes likely to occur (p. 7).

Fullan (1982, 1985) supported Guskey's conception of change as occurring after implementation; however, both researchers relied upon anectdotal and correlational data to develop their causal theories. In particular, Guskey identified several studies in which the only teachers to change beliefs were those who adapted the innovations.

It is not necessarily true that the teachers in these studies changed their beliefs after implementation just because a pre/post-test comparison indicated that their beliefs had changed. In the studies Guskey cited, what was going on in the minds of the teachers was never examined throughout the change process. However, in more recent studies of teachers' changing beliefs in the process of staff development, evidence exists that teachers change throughout the process (Au, 1990; Johnston, 1988; Richardson & Anders, 1990; Taylor, 1990; Tobin, 1990). For example, based on evidence from interviews and videotaped lessons of several subjects in their study of a staff development project focused on the use of research in reading instruction, Richardson, Anders, Tidwell, and Lloyd's (in press) indicated that several teachers shifted from more traditional beliefs and practices to more constructivist notions throughout the study. In particular, Susan "seemed to indicate that she was moving toward a more literature-based approach. She was already moving away from the notions that meaning is in the text" (Richardson et al., in press, p. 14).

Fullan (1985) described research agendas about staff development as dealing with either "theories of change" or "theories of changing." Research questions related to theories of change asked, "What factors explain change (or the failure to change)?" These were addressed by researchers during the 1960s and 1970s. Questions related to theories of changing asked, "How do changes occur?" and "How is new knowledge used in the process of change?" These questions were predicated by the work of Doyle and Ponder (1977) and pursued during the 1980s. Tracing researchers' shift from focusing on institutional factors impacting change to individual characteristics in a critical analysis of implementation research, McLaughlin (1987) posited that future implementation processes must focus on the individuals involved and their social interactions, decision-making, and reflections regarding the intended changes in practice. Evidence of the role of teachers' cognitive processes has emerged as a viable research topic (Clark & Peterson, 1986; Duttweiler, 1990; Kagan, 1990; Shroyer, 1990).

To inform the development of a theory of changing, this is a longitudinal case study of one teacher's changing beliefs as she participated in a staff development project that was designed to change not only *what* she believes but *how* she teaches, as Shroyer (1990) and Duttweiler (1990) suggested. Changes in beliefs were examined throughout

the process. This research study focused on the following questions:

1. In what ways do a teacher's beliefs change after participating in a particular type of staff development project?
2. In the teacher's language, how is the change exhibited throughout the process of changing?

Conceptual Framework

Towards defining beliefs. This study focuses on a teacher's process of changing; specifically, the changes in her beliefs after and throughout her participating in a particular staff development project. Debbie, the subject of this study, has taught senior high school science for sixteen years. Debbie said she participated in the staff development project about thinking skills to learn how to implement the Hilda Taba teaching strategies and to improve her questioning skills. She was involved in a process of changing her beliefs about learning and about questioning. According to Sigel (1985), these would be her *what* beliefs and her *how* beliefs; both must be addressed to predict a change in her behavior.

Beliefs have been defined in a variety of ways. In their extensive review of the literature, Eisenhardt, Shrum, Harding, and Cuthbert (1986) found many definitions of beliefs upon which current research has been based. As represented in the studies these researchers reviewed, the inconsistencies in the definitions they noted may be attributed to the foundations of the research agendas cited. Some rely upon anthropological studies; others upon sociological, psychological, or philosophical agendas. These differences are highlighted in additional reviews conducted by Clark and Peterson (1990), Hamilton (1989), Kagan (1990), Richardson and Anders (1990), and Ponticell (1991).

Despite their differences, most definitions of beliefs and belief systems contain referents to concepts or other linguistic representations and to truth and, in some instance, to action. From an anthropological perspective, beliefs "refer to some unseen intellectual/emotional activity of human beings" (Black, 1973, p. 511) and include a broad range of definitions including those that focus on native knowers' codification of reality, communication systems, themes, world views, and semantic structures. For example, Goodenough (1963), an anthropologist, explained that a belief system includes precepts, concepts, language, and propositions about the precepts and concepts that the believer holds to be true. More frequently referring to beliefs as ideology, sociologists such as Berger and Luckmann (1967) and Rokeach (1968) define beliefs as socially constructed understandings of reality, or ideas, held to be true, learned, and shared within a society. In psychology, definitions of beliefs, like Kelly's (1955), refer to representations the individual assigns to elements of the real world. Harvey (1986) defines a belief system as a set of conceptual representations signifying to its holder a reality of sufficient validity, truth, and/or trustworthiness to warrant reliance upon it as a guide to personal thought and action. A cognitive scientist, Abelson (1979) defines a belief system as a "network of interrelated concepts and propositions at varying levels of generality . . . and processes by which a human . . . accesses and manipulates that knowledge under current activating circumstances and/or in the service of particular current purposes." Philosophers, such as Fenstermacher (1986) and Green (1971, 1976) define beliefs as propositions or statements of the relation among things accepted as true. They apply this definition to their discussion of the practical argument, a series of propositions which explain the believer's actions.

In many explanations of the differences between beliefs and knowledge, the veracity of the proposition distinguishes beliefs from knowledge (Abelson, 1979; Black, 1973; Lehrer, 1990; Sigel, 1985). Sigel (1985) includes this differentiation in his definition of beliefs, which will provide a foundation for this research. Sigel (1985) proposed the following definition:

> Beliefs are knowledge in the sense that the individual knows that what he (or she) espouses is true or probably true, and evidence may or may not be deemed necessary; or if evidence is used, it forms a basis for the belief but is not the belief itself . . . In sum, beliefs are constructions of reality. They may incorporate knowledge of *what* and knowledge of *how*, but do not necessitate evidential propositions. Beliefs are considered as truth statements even though evidence for their veridicality may or may not exist. (pp. 348-349)

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For purposes of this research, beliefs are defined as an individual's "mental constructions of experience--often condensed and integrated into schemata or concepts" (Sigel, 1985, p. 351) that are held to be true and may guide personal action.

Beliefs and schemata. If beliefs are mental representations integrated into schemata and concepts, the following assumptions about schemata and concepts may apply:

1. Beliefs may be held as semantic networks similar to concepts and schemata (Abelson, 1979; Anderson, 1983; Donald, 1987; Fisher, Faletti, Patterson, Thornton, Lipson, & Spring, in press; Howard, 1987; Novak & Gowin, 1988; Sigel, 1985).
2. Contradictory beliefs may exist within different knowledge domains (Abelson, 1979; Donald, 1987; Sigel, 1985).
3. Certain beliefs may be core beliefs, and, like core schemata, these core beliefs may be difficult to change (Abelson, 1979; Green, 1971; Howard, 1987; Nisbett & Ross, 1980).

These assumptions frame the methodological design of this study. Comparisons of semantic maps of Debbie's initial and final interviews yielded distinct similarities and differences in her beliefs about learning and teaching. The similarities may represent Debbie's core beliefs--those that form the basis for most of her practical arguments--the primary premises of her explanations for her actions (Fenstermacher, 1986; Green, 1971, 1976). The differences may represent changes in her peripheral beliefs, those most easily examined, discussed, and changed (Green, 1971; Howard, 1947; Nisbett & Ross, 1980). Semantic maps of Debbie's intermediate interviews were analyzed to examine changes in Debbie's beliefs throughout the staff development project. A narrative of these changes was written to combine semantic maps and field notes in a representation of the ideas and actions that provoked Debbie throughout the process of changing.

Methods

As part of a larger study at a suburban high school in the Midwest, this case study is the story of one science teacher, whose beliefs about how students learn began to change during her participation in a staff development project. The nine-month research project required that the twelve teachers engage in all of the staff development activities, including attending monthly structured classes, preparing at least three audio-taped model lessons and their analyses, and participating in five audio-taped, structured interviews. Because they involved some questions about the content of the classes and the teachers' lessons and about the teachers' beliefs, these interviews were integral to both the staff development and the research processes. The subject of this study, Debbie, participated in each class, completed each of the taped model classes and follow-up analyses, and participated in each structured interview. The researcher, who also served as the staff developer, recorded and transcribed each interview and maintained field notes regarding her interactions with her subjects and her impressions of the staff development project and the process of changing.

Staff development: Intervention and data source. The staff development project was both an intervention and a data source. While the project included classes that served as an intervention to facilitate change in practice and beliefs, follow-up interviews, audio-taped class sessions of participants' practicing the strategies introduced, and field notes about the classes, interviews, and other interactions with school staff served as data sources along with tapes of the staff development classes. The staff development classes were designed for the researcher, or staff developer, to model the Hilda Taba Teaching Strategies (Institute for Staff Development, 1970), to introduce key concepts of cognitive science and constructivist notions of learning, and to collect data about the teachers' beliefs.

The teaching strategies are based on Taba's theory of curriculum development, which employs content generalizations rather than behavior objectives as the framework for curriculum design (Taba, 1962, 1966; Taba, Durkin, Fraenkel, & McNaughton, 1971; Taba & Elzey, 1965; Taba, Levine, & Elzey, 1964). Further, the strategies involve students in discussions that require their providing "data" or facts about an incident or event, their reasoning about relationships among the data they provide, and their forming generalizations about the concepts discussed. As presented in the staff development project, the Taba teaching strategies engage students in a structured discussion that consistently moves from a focus on concrete examples to broad, abstract generalizations about their

relationships. The teacher asks open-ended questions, records students' responses in their own words, and requires students' providing reasons for their responses and conclusions. Although in planning a Taba strategy, the teacher carefully maps the discussion, probable responses, and a focusing generalization, what students know and how they respond to the questions comprise the evidence students use to draw their own conclusions about the content of the discussion. Thus, the strategies are somewhat open-ended and require students to make inferences and judgments about the information their classmates provide. The teacher plays the role of director, questioning students along the way. Because the strategies can simply model the use of prior knowledge in the construction of knowledge and because they complement the content regarding cognition and constructivism, they were incorporated into the staff development project by the researcher.

The 12 teachers attended seven class sessions, at which they discussed their own theories of how students learn and those theories presented by Bransford and Johnson (1972), Neisser (1976), Resnick 1987), Rumelhart (1980), Taba (1962, 1966), Taba, Durkin, Fraenkel, and McNaughton (1971), Taba & Elzey (1964),Taba, Levine, and Elzey (1964) and von Glasersfeld (1987). Three of the discussions were framed as models lessons of the Hilda Taba Teaching Strategies: Concept Development, Interpretation of Data, and Application of Generalizations. The content generalizations which focused these three model discussions framed the content of the staff development project. The model Concept Development lesson focused on learning, Interpretation of Data on the effects of cognitive dissonance on learning, and Application of Generalizations on the difficulties and complexities involved when school change occurs. The researcher designed these lessons both as models of the strategies the participants were to learn and as thought-provoking discussions to challenge the participants' current beliefs about how students learn. Unlike some staff development projects in which the coordinator models lessons that are student-oriented, lessons the teachers might use in their classrooms, these lessons were intentionally teacher-oriented and included content about schooling to engage the teacher as learner (Fullan, 1990).

Each class session was audio-taped. After each class that included a Taba model, the participants were required to design, implement, audio-tape, analyze, and discuss a model lesson for their own classes. Transcriptions of the audio taped staff development classes, participants' trial lessons, discussions between the researcher/staff developer and the participants, structured and informal interviews, and field notes served as data for this study.

Debbie. The subject of this study, Debbie, is a 37-year-old science teacher, who had been teaching for 16 years at the onset of the staff development project. Debbie was sponsor of the senior class, and involved in both academic and extra-curricular activities at the school. Recently, she began a masters' degree program in administration and supervision at a prestigious Midwestern university, hoping to secure an administrative certificate and move into a school-site or district-level administrative position that involves her working in the area of curriculum. As an undergraduate, Debbie was a science major, who interned at the school where she now teaches. "The thing that I am constantly amazed about teaching is that I like it more and more as I go on," Debbie said as an addendum to her first interview, expressing the enthusiasm that underlies her personal beliefs about teaching and learning.

Interviews. The subject was interviewed at the end of the first semester of the 1989-1990 school year, in January--prior to participation in any staff development activities, at monthly intervals throughout the project, at the beginning of the 1990-1991 fall semester--four months after the project ended, and briefly before this paper was written. Questions included in the interviews were written to elicit both declared and private beliefs (Goodenough, 1963; Richardson-Koehler, 1988; Richardson-Koehler & Hamilton, 1988). To elicit responses about the subject's declared beliefs that were recorded in the subject's own language, the pre- and post-interviews included questions based on the Kelly Repertory Grid (Kelly, 1955; Munby, 1982, 1984; Olson 1980; 1981) as revised by Munby (1982).

In addition, questions to elicit the subject's private beliefs about learning were included, as Kelly (1955) and Richardson-Koehler and Hamilton (1988) recommended. These questions were based on the Heuristic Elicitation Method (Eisenhardt et al, 1988; Richardson-Koehler, 1988; Richardson-Koehler & Hamilton, 1988). For example, the subject was initially asked, "Think about a recent class session where you just knew learning was taking place. What were students doing? What were you doing?" Later, she was asked, "Think about something you learned recently. What was it you learned? What did you do to learn that?" Finally, she was asked, "If you had two weeks free to learn anything you want, what would it be? What would you do to learn it?" The initial questions were designed to elicit the subject's declared beliefs; the latter to elicit private beliefs (Goodenough, 1971).

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Intermediate interviews throughout the study involved discussion about the researcher's and the teacher's analyses of the model lessons and an ongoing dialog about how students learn, what the teacher was learning, and how she knew that she and her students had learned something. To complement categorical data elicited in the pre- and post-interviews, several questions in each of these interviews were designed to elicit critical incidents (Flanagan, 1962). Critical incidents are those that the subject can recall with the most detail possible. This detail allows for a categorical analysis of the interviews to determine the characteristics of the core concept; in this case, learning.

Analysis

Interviews and semantic maps. The transcribed data from each interview was used to develop semantic maps, which graphically represent the subject's understanding of the concepts. Many researchers use semantic maps to represent subjects construction of concepts and the relations she sees among them (Anderson, 1983; Donald, 1987; Fisher et al, in press; Novak & Gowin, 1988), as mental models are key to theories of cognition that include schemata as the building blocks (Neisser, 1976; Rumelhart, 1980) .

To develop conceptual maps, or semantic maps, from interview data, Novak and Gowin (1988) suggest framing interview questions to include the types of relationships among concepts to be analyzed. For example, to elicit responses about the relationship between what students do and learning, the researcher asked, "Think of a classroom where learning is taking place. What are the students doing?" Similarly, questions regarding the relationships between learning and what the teacher does, what students do to demonstrate it, what the teacher does when she is doing it, and what she does to demonstrate it were included in the interviews. The responses to these questions were mapped to develop a semantic network of the teacher's understandings of these relationships. (For example, see Figures 1 and 2, central parts of the semantic maps of Debbie's initial and final interviews, respectively).

Insert Figures 1 and 2 about here

Using the subject's words and phrases as concepts but using the relations implicit in the questions asked, a semantic map with learning as the central concept was developed for each interview. The extent and content of each map, however, were dependent upon the subject's responses. Each map includes similar sets of relations among learning, activities, and assessment, determined by the pre- and post-interview questions. Words Debbie used to name and describe learning, activities, and assessment were represented as *concepts* in the semantic maps and appear in the squares and ellipses. Verbs and adverbs from the interview questions were represented as the *relations* among these concepts and appear on the lines connecting concepts. An *instance* is any combination of concepts and relations stated by the subject.

In each interview, Debbie was asked to tell what students and the teacher do when learning takes place, how the teacher knows students have learned something, what she does to learn something new, and how she knows when she has learned something. Therefore, the central concept of each map was *learning*. Relations among learning, activities, and assessment were included questions like the following items:

1. What else do students do when they are learning?
2. What else do you do when you are learning?
3. Which activities would you put together because they are alike in some way?
4. Think about a student in your class who recently learned something new. What did he or she learn? What did he or she do to learn this?
5. Think about a new subject you learned recently. What was the subject? What did you do to learn this subject?
6. How might you know when you've learned it?
7. How do you know when a student has learned something?

Thus, the relations among learning, activities, and assessment used to develop the semantic maps included the

following phrases:

1. *Includes* (for activities and categories of activities in which teacher or students engage while they are learning, as stated in response to the first three questions)
2. *Also occurs when Ss* (for additional activities named in response to questions like the fourth)
3. *Also occurs when I* (for ways in which the subject learns, as stated in response to the fifth question)
4. *I know I* (for how the subject knows when she has learned something, as stated in response to questions like the sixth)
5. *I know Ss* (for how the subject knows when students have learned something, as stated in response to questions like the seventh.) (See Figures 1 and 2, which are the central maps of the pre- and post-interviews of this subject and included examples of these concepts and relations, as expressed by Debbie.)

The central maps include instances of the relations among the concepts representing learning, activities, and assessment as Debbie stated them. Each map was then extrapolated to represent the entirety of Debbie's responses to all of the questions in the interview. That is, extensions of the map included additional relations implicit in each interview question and the concepts and instances provided by Debbie in her response. For example, when Debbie labeled one group of activities as "Traditional kinds of things," the researcher asked, "What do you mean by . . . ?" Debbie's response was "I think of those as being just traditional kinds of things that are always quick and easy ways, possibly the most efficient way to get information across--although not necessarily the longest lasting. I guess most of those kind appeal to traditional good students, too." "Traditional kinds of things" and other nouns and descriptors Debbie used in her explanation were noted as concepts on the map; the relation was indicated as *is defined as*; and an instance was "Traditional kinds of things is defined as quick and easy ways". (For example, see Figure 3 for the extrapolation of this response.)

Insert Figure 3 about here

Domain and descriptive analyses: Towards defining Debbie's beliefs. Two analyses were used to determine the ways in which Debbie's beliefs changed after participating in the staff development process. The semantic maps developed from the pre- and post-interviews provided a framework to facilitate a domain analysis as suggested by Spradley (1979) and corroborated by Flanagan's (1962) categorical analysis. A descriptive analysis provided a framework to identify cultural themes or propositions which predicated Debbie's practical arguments and to write a narrative to express the findings.

Domain analysis. The domain analysis included three categorical analyses of the data collected as responses to the initial question of the pre- and post-interviews. This question was similar to those Kelly (1955) used to create a repertory grid and revised by Munby (1982, 1984). The quantitative and qualitative categorical analyses involved the following procedures:

1. Analyses of the number and types of activities that occur when learning takes place involved counting the activities Debbie named and noting those in which the teacher, the students, or combinations of the two were included.
2. Analyses of the number and types of categories into which Debbie placed the activities involved counting and identifying the function of the categories identified (Spradley, 1979).
3. Analyses of the number and types of instances or connections among the activities and categories Debbie stated involved counting these connections and identifying the nature of activities and the participants included in each category.

By outlining annotations of Debbie's responses to these questions, counting and describing the types of activities, categories, and connections was simplified. (See Figures 4 and 5 for the outlines of the pre- and post interviews, respectively. On the left is the list of the things the students and teacher do when learning takes place, on the right is the list of categories into which she placed them, and the lines indicate the activities' placement in the category.)

Insert Figures 4 and 5 about here

Then, using these domain analyses and similar analyses of the remaining questions in the initial and final interviews, the researcher wrote a descriptive analysis of the pre- and post-interviews, addressing questions about how students learn, what the teacher and students do when learning takes place, and how the teacher knew students had learned.

Cultural themes. These domain and descriptive analyses were examined to determine qualitative differences in the subject's beliefs about learning. These qualitative analyses of the teacher's responses were used to explicate the subject's beliefs as what Spradley (1979) called cultural themes, which he defined as "any cognitive principle, tacit or explicit, recurrent in a number of domains and serving as a relationship among subsystems of cultural meaning" (p. 186). These principles, or propositions, and their supporting descriptive analyses framed a case study of the ways in which Debbie's beliefs about learning changed.

Narrative. To address the question of how these changes were exhibited throughout the process of changing, the same analyses of the intermediate interviews were completed and augmented by data from the staff development classes and the researcher's field notes. The researcher synthesized all of these analyses to create a narrative of Debbie's process of changing, that is, Debbie's story (Barone, 1990; Clark, 1990; Connelly & Clandinin, 1990). The narrative provides a sense of the whole process and does not imply any cause and effect relationship but rather "brings theoretical ideas about the nature of human life as lived to bear on educational experiences as lived" (Connelly & Clandinin, 1990, p. 3). The validity of this case, as Wolcott (1990) suggested, lies in the telling of Debbie's story in as many of her own words as possible.

Findings

Debbie's change in beliefs. During the nine months in which Debbie participated in this study, her beliefs about how students learn changed. In her post-interview, Debbie named two more activities than in her pre-interview, included more activities involving the teacher, one more category of activities than in her pre-interview, thirteen more connections among the activities and the categories, and several more categories that included the interactions among the teacher's and students' activities. (See Figures 4 and 5, which display outlines of Debbie's responses.) In addition to these quantitative differences, the categories of groups into which Debbie placed the activities during the final interview named relationships among the activities rather than the functions of the first interview. These findings included differences in the number and qualities of the responses Debbie gave.

In her initial interview, Debbie listed 17 activities in which the students and teacher engage when learning takes place. Students were taking notes, reading, doing a lab, talking, working on lab questions, trying to identify unknowns, helping each other, applying skills gained in labs, building models, making connections, asking questions, working with each other, explaining concepts to each other, and doing well on quizzes, while the teacher was lecturing, circulating, answering questions, asking students to help each other, and demonstrating problems. According to Debbie, students learn by applying information, making connections, helping each other learn, and participating in traditional- and experience-type classroom activities, the names she gave to groups of activities she made. "... students being animated! That's what I am missing here!" Debbie exclaimed as she started a second sorting of the activities. "I really know that learning is taking place when students are animated in their questions rather than just like, 'Will you say that again?'" As well, she noted, students learn when they talk about their work, role-play, and hear short lectures. "I usually just jump in, start doing it, and learn as I go," Debbie said, "... It will take extensive hands-on time with no outside interruptions." As shown in Figure 4, Debbie made 22 connections among her activities and categories. (See Figure 4 to examine these connections.)

Debbie's initial proposition about learning might be summarized simply as ***Through activity, students learn.*** This proposition is supported by a domain analysis (Spradley, 1979) of the categories of activities she derived. Each category names the function of or includes the activities within it. For example, "Applying information students find" names the function of building models, doing well on quizzes, explaining concepts, and identifying the

unknown; and "Traditional kinds" of activitites includes students asking questions, taking notes, talking about the lab, while the teacher answers questions, demonstrates problems, and lectures. In this interview, "Traditional kinds" is the only category that includes both students' and teacher's activities. Even though the students were engaged in a laboratory experience, that was "hands-on," the teacher played a "traditional" role of giving information, which the students "find," in Debbie's words. Therefore, Debbie also proposed initially, ***When they learn, students are given or find knowledge.***

In this interview, Debbie seemed to project the teacher as an interloper, a one-way communicator. In her examples, while the students were frequently engaged in interaction, working in small groups and teaching each other, the teacher delivered information in "traditional" activities such as demonstrating, answering student questions, lecturing while students take notes, and reading. These "traditional" activities ". . . are always quick and easy ways, possibly the most efficient ways to get information across, although not necessarily the longest lasting" Debbie said. ". . . I still think that the most efficient way to get information across is short lectures."

These traditional activities are different from those in which students "are applying information they've come up with," such as identifying unknowns, building models, doing well on quizzes, and explaining concepts to each other. When applying information, she said, students are " . . . not just in the process of gaining knowledge, they're actually using it." She explained her concern that the teacher was not always going to be there for students. This motivated her to encourage students to help "each other to learn the material without a lot of outside influence from the teacher."

After the staff development project ended, summer vacation passed, and the new school year began, Debbie talked about learning differently. As in the first interview, during the last interview of the study, Debbie focused on a laboratory experience when she was asked to recall a classroom where learning was taking place. She named 19 activities in which the students and the teacher were engaged. While the students were doing the lab, moving, putting together equations, measuring, calculating, deciding, discussing, observing, hypothesizing and guessing, interacting, enjoying it, working sample problems, and graphing, the teacher was moving around, answering students' questions, asking questions, bringing students back, repairing, pointing to the wrong answer and saying, " . . . reconsider?" Students learn by being active, engaging in the scientific method, doing paper-and-pencil tasks, doing it on their own, and interacting with other students and with the teacher, who sometimes directs activities, with the end results always in mind, Debbie said, as she labeled the categories into which she placed the activities. E shog in Figure 5, Debbie described a much more complex system of beliefs about learning this time, making 35 connections among the activities and categories (see Figure 5).

In the final interview, Debbie proposed, ***By interpreting what they experience and interacting with others about what they see and know, students learn.*** They record, graph, and translate data, comparing it to what has been done before and to what happens in the real world. Debbie indicated there were cause-and-effect, means-to-an-end, and sequential relationships, not just functions and characteristics, among the activities and the categories she named while sorting activities this time. In fact, the language Debbie used to describe these activities indicated the students' and teacher's mindfulness about the activities in which they were engaged. Rather than just doing, helping, taking, working, and identifying, students were deciding, interacting, observing, discussing, and hypothesizing. More frequently, the teacher's activities were intermingled in categories among the students'. Obviously, "Students interacting and teacher interacting" included what the students were doing and what the teacher was doing. The teacher was directing students' attention or interacting with students. "Learning just doesn't happen in the classroom," Debbie said, "Learning is going on no matter where you are."

Although social interaction was an integral activity in learning during her first interview, new insights about the significant role of interaction in learning was supported by a change in Debbie's personal learning style. During her summer in graduate school, she had learned about case studies by participating in "group work, which I've never been big on doing personally." Further, when asked how she knew she had learned something, Debbie said, when I "know I can convince someone else of it." By thinking and interacting in a group about what they do, see, and know, students learn.

In this final interview, Debbie projected the teacher as an active participant whose questions and directions guide

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students to put the puzzle together and to synthesize--not just to apply information. For the first time, Debbie expressed an interest in what was going on in the students' minds and what information they brought to the learning experience. In the lab Debbie described, she talked about students hypothesizing and guessing, deciding, talking in a group discussion, and observing. She grouped these activities as "when they are really focussed on going through the scientific method of what's happening. Those are really the steps they are going through mentally as they are organizing themselves." She implied by this that, ***Learning is making sense of the world by organizing information about experiences.***

Debbie clearly recalled her experience of listening to a nonsense story examined in one staff development class. In this story, many familiar concepts are used to describe an event. While reading or listening to it, people ascribe various meanings to these concepts--none of which lead to an understanding of the whole story. Like subjects in the Bransford and Johnson (1972) studies who heard the confusing story, Debbie listened and struggled to make sense of it. When shown a picture that re-established the inconsistent relations that tied the concepts together, she understood. Recalling this activity during the final interivew, Debbie talked about the importance of having "what you want to aim for" in mind while teaching. "If you don't start off . . . clearly, then you've got the kids lost to begin with . . . But, then, when you put the picture up, . . . 'Ah! That's what goes with it!'" One of Debbie's categories in this last interview was "The end result . . . That's what I want them to do . . . I want students to make decisions and . . . to put together the results. It's like a synthesis . . ." The teacher is no longer an interloper, she is a guide, directing students' "making decisions," a concept at the core of at least three relations Debbie established.

The difference between how Debbie initially described knowing how students have learned something and her final description exemplifies her shift in beliefs from a positivist notion of "finding" or "giving" information to a constructivist notion of "making sense." Initially, Debbie saw the "light bulbs go on" when students have "found a place for the information I've given them." This occurs when "students make connections to previous labs" and are "being animated in their questions," she said. Debbie knew students had learned when they could teach it to other students, do a whole new sample problem, do well on quizzes, or build models accurately. "It all boils down to a quiz," Debbie said, even though she knew she had learned something when she could do it. After participating in the staff development process, Debbie described the "light bulb going on" in more and different ways. Students' transformations and representations of what they were learning were implicit among the examples of activities, such as hypothesizing and putting equations together, that Debbie recalled in her last interview. Further, she said she knew students had learned when they could translate the demonstration into words and graphs that match. The light bulbs go on when students see the connections between what they learn in science and in other classes. "'Wow, that's why we learn how to take slope in math!' . . . They get this expression like 'Everything is meant to work out, you know' . . . 'Oh, that makes sense now!' or whatever. Obviously on a test, too; but sometimes in a test situation, kids can't necessarily, on order, reproduce it. But if they get that light bulb going off that you see in their faces . . .then you know that it at least got through somehow, at least for a while."

Debbie's Process of Changing. The changes in Debbie's beliefs throughout the staff development project were reflected in her attention to specific content of the staff development project; in her resistance to specific, powerful ideas; and in her questions and reflection about why she teaches what she teaches. These changes in her beliefs occurred over time, as stated in her intermediate interviews. Related changes in her practices occurred gradually, as well, as demonstrated in audio-taped lessons she implemented and in interviews when she discussed changes she intended to make in her classroom activities. For example, during the final interview, Debbie reported making changes such as incorporating concept mapping and more Taba strategies and including questioning and discussions modeled in the staff development classes. During the fall semester following the project, Debbie helped to organize an ongoing staff development project, including the participants of the original study in activities to help them master the Taba teaching strategies.

The analyses of Debbie's intermediate interviews, staff development classes, follow-up discussions of her trial strategies with the researcher/staff developer, field notes, and interviews with other staff members provided insight about the process of Debbie's changing beliefs. Several components of the staff development project seemingly piqued her interest and surfaced in her conversations throughout the study. Further, her conversations revealed her resistance to, depression about, and conviction to her emerging beliefs in learning as a "sense-making" activity. The following narrative provides an account of Debbie's process of changing.

Throughout the study, Debbie worked diligently to master the teaching models. "Just tell me the rules; I'll play the game," she said in her first interview. ". . . just light the fiery hoops," she continued about her university experience, "I'm ready to jump through." But, the allusion to "fiery hoops" and "games" disappeared once Debbie's classes were under way (at the university and the high school). "I enjoy this," she explained. "You get involved whether you want to or not." More frequently and in greater detail than most other subjects in the overall study, in her interviews, lesson plans, and evaluations of her lessons, Debbie reflected upon the content and process of each teaching strategy she devised, taped, and analyzed. More vocally than other subjects, Debbie demonstrated a resistance to the content and process of the staff development project.

First of all, Debbie insisted that the Taba teaching strategies were inappropriate for every subject. In February, during her second interview, she talked about discussions she had with a mathematics teacher engaged in the project. They agreed that the Taba strategies might work in social studies or English but not easily in mathematics and science. Debbie said:

> In science, I do see some applications for it, but not as many as I'd like . . . , and this is something that we're pretty aware of. We're at a pretty concrete level when teaching science. We do need to do more concepts. The problem that we have in the most conceptual course that we teach to freshmen (is that) the freshmen have a hard time with concepts. A lot of those are very, very abstract, like *osmosis* and *diffusion* . . . (students) really don't have a handle on them (concepts). It's really strange, but I can really see Taba having applications. Then when I go to try to use it myself, it's more of a difficult thing.

Despite her resistance, Debbie continued in this interview to design a Taba lesson about energy conservation. She reiterated he notions of concept maps, abstract and concrete, and cognitive dissonance discussed in the staff development classes. "That's what I'll have to do," she said after discussing her next lesson plan with the researcher. "I'll have to sit down and think about it;" reflect.

In early April, the Taba strategy modeled in one of the staff development classes focused on the complexities and difficulties of school change. Participants had read Resnick's (1987) article about the differences between school and practical intelligence, "that matters more in real life" (p. 13). "If Resnick were the superintendent of schools, what do you predict she would want to see happening in classrooms?" the researcher asked during the modeled teaching strategy. Before the discussion began, Debbie burst out, "That article made me very angry," and explained how she had read aloud excerpts to her husband as they settled into bed the night before. "Schools just can't be like that," she said.

At the end of the class discussion, Debbie expressed her continued concern about the concrete-level of most of her curriculum. She wrote the following:

> Most of these techniques make me question the value-level of what I teach. If it is difficult to find anything other than trivial waste to apply them to, then, am I teaching the right thing? Everything is on a very concrete level. No big ahas! Only trivial pursuit knowledge!

That morning, Debbie had read a Chicago Tribune article denouncing schools for teaching "trivial-pursuit knowledge;" that is, students were learning only answers to questions in the popular board game. This disturbed Debbie. "Assessments support this," she said. "The district wants me to give these assessments, and that's how I design what I do." Debbie continued, "Or, I can start to say, 'Okay.' I can smile and play that role or do what I know is right and be a risk taker."

> During the next day's interview, which occurred during the third month of the project, Debbie said: Yesterday I was really depressed, because it hit me . . . that (Taba strategy) would be really hard to apply with anything I teach, because I don't teach anything, or very few topics, deeply enough that I can raise it to that level of abstraction for students. That makes me wonder, "If I can't use a critical thinking technique, why am I teaching what I'm teaching?" . . . I know that part of it is that we have become fairly assessment driven . . . but, there's still got to be a way to work around that situation so that there is something for students to have other than trivial pursuits knowledge of physical science and physics.

At this time, Debbie began talking about her reflections on students' making sense of their worlds and their putting the pieces together, and her role in their learning. She talked about what she thought was the most important thing she learned in the staff development project so far in the following manner:

> I guess something that I have to be reminded about (is) that nothing makes sense to kids unless you give them a place to file it away. You can't just give them random information . . . Picture their brains attic-like rather than filing cabinet-like. They need to have a place . . . they need to know where to file it away. So, even though it takes more time, . . . I need to make sure they have a good introduction, a good start, a good beginning for where to put it.

Despite her concern about time and about her feeling pressured by administrators to cover the content so that her students might do well on district-level assessments, Debbie reiterated her new questions about teaching and learning as follows:

> I really think we're going to have to reduce the amount we cover in here. Because, there's no way. You just keep plowing ahead . . . The week before last I spent about two days in physical science doing the Taba lesson we talked about last month, and then actually my kids asked if they could write a letter to their state senator about some recycling ideas. I'm going, "Okay, I think we can fit that in." In the meantime, the next week I had to rush through the material that was on the test; and, as a result, their grades on the test were not as good as they normally are. But, I think they have more feeling for what the subject is. Now, how do you explain that?

In May, Debbie talked more about her role and that of the students' prior knowledge in learning. She expressed a way of knowing when students had learned something that was unlike others she discussed previously yet that was similar to the final step of each Taba strategy. She knew students had learned about the variability of the strength of electromagnets, Debbie said, "Because at the end, they could summarize. They could make some general statements about electromagnets. They could write a paragraph that generalized what they had learned that day."

Connections were important for both students and the teacher in this interview, and the meaning of connections shifted to include experiences outside of school as well as to those inside. "I know I have learned something," Debbie explained "when I can make connections to something else." She continued to explain how during the first several years of teaching science, she saw each topic the same way, year after year in the following fashion:

> It starts being very repetitive . . . then, suddenly "Gee! That's like something else." Then you learn . . . to help kids make those connections while you're teaching, as well, so they can see some analogies to other situations, and they can see connections to other subject matters.

Debbie talked about teaching. "Teaching is like helping kids put the pieces of a puzzle together, because they do have a lot of random knowledge, but they just don't know where it fits yet." She extended her metaphor as follows:

> You have to, starting at the beginning, find out where they are, what their bits of knowledge are. Then you try to help them put it together into a logical picture by showing them that you turn the picture this way and that . . . "Turn the pieces around the other way; flip them over; and arrange them." Show them how to group their information. "All the pieces that are green may be grass." Again, try to help them organize what they know into some logical picture . . . I am really more aware . . . I spend a lot more time talking about it, introducing it, laying some groundwork, and making it real for them before I try to extend what they know about the subject . . . I'm more aware that they have data . . . it's just helping them take their database and organize it, and add to it . . . I am really trying to help students make connections and thinking through where I want them to end up at the end . . . You start reminding yourself that you're not just teaching subject matter, you're teaching a kid. And, there's something going on in the kid's head . . .

Thus, Debbie's role as the director began to emerge.

In September, Debbie recalled her metaphor. "Teaching is helping students manipulate puzzle parts, helping them

put it together, without doing it for them." She explained as follows:

> I don't think you can put a puzzle together for someone . . . whenever you even put a puzzle together for even a little kid, they always want to dump it right out again, because they didn't do it themselves. (Teaching) is the same thing . . . I think you just have to help them, guide them to do it . . . Otherwise, they are going to shuffle (the pieces) and try again anyway.

Further, she explained that everyone's puzzle was not the same, "including colors . . . the blue that I see isn't necessarily the blue that you see."

Discussion

Debbie's beliefs about how students learn shifted from a belief that students learn simply by doing classroom activities to one that students learn by mindfully engaging in experiences inside and outside of the classroom. In both the initial and final interviews, Debbie talked about students doing laboratory experiments and interacting with other students and about the teacher answering questions. Only one category in each interview included activities involving the teacher and students: "traditional kinds" from the first interview, and "students and teacher interacting" from the second interview. The difference between the names and contents of these two categories mirrors Debbie's theoretical shift from a behaviorist view that doing is learning to a constructivist view that sense making is learning.

"Traditional kinds" of activities including, in Debbie's words, the teacher's "anwering questions," "demonstrating the problem," and lecturing while students were "asking questions" and "taking notes" reflect a behaviorist view that the teacher tells students what they should know and students learn by recording what was said. Activities in which "students and teacher (were) interacting," including the teacher's "answering questions," "asking questions," "bringing students back," and "point to the wrong answer and asking" while the students were "interacting" and "discussing" reflect a constructivist view that through social interaction, the students are making sense of their world and their activities. In the latter case, the teacher interacts with the students, facilitating the sense-making activities with open ended questions about what students are doing and thinking. Thus, Debbie's propositions shifted from ***When they learn, students are given or find knowledge*** to ***Learning is making sense of the world by organizing information about experiences.***

Because *students' doing* and *students' interacting* were related to learning by Debbie throughout the project, these concepts may be key elements of Debbie's core beliefs, formulated in her own classroom experiences. These were key concepts in her introductory through graduate coursework in science education, she explained. Further, the science curriculum she followed was laboratory-based, involving students in doing experiments and interacting with other students about their findings. Perhaps because these beliefs were indoctrinated throughout Debbie's career in schooling—as a student, as a student of teaching, and as a teacher, these core beliefs remained constant. Green (1971) Howard (1987), and Nisbett and Ross (1980) discussed the difficulty in changing beliefs that are formed without evidence. Further, Sigel (1985) stated that the likelihood of change "depends on whether or not they are evidentially based" (p. 348). Perhaps Debbie's more peripheral beliefs about her role in the learning process changed, because she trusted the new evidence with which she was consistently confronted in her readings, discussions, and experiences.

As she struggled with *what* about learning and *how* to teach, Debbie engaged in the process of changing. Throughout the staff development project, she followed a path of resisting, questioning, and assimilating new information and new practices. Initially, Debbie resisted *what* she was learning about concepts and schemata from the content of the staff development activities. "We do need more concepts (in science)," she said in February, ". . . (but) students don't really have a handle on them." As well, she resisted *how* she might implement new teaching strategies. "You can't do that in science," she said in February. "Schools can't be like that," she echoed in April. Yet, as she prophesized in her initial interview, "You get involved whether you want to or not," and Debbie "got involved," reading, discussing, practicing, analyzing, and reflecting.

"How do I play the game?" Debbie asked at the onset, and throughout the process of changing, Debbie focused both on *what* the game was and *how* she played. First the game was defined by school district policies that outlined what was to be taught in each science course and that mandated annual, district-level assessments of what students knew

about this content. Debbie explained that she played the game by working with science teachers from the other four high schools in the district to plan her classroom activities, relying upon what they agreed worked and what she knew had worked before. By April, however, when Debbie found that students' "grades on the test were not as good as they normally are, but I think they have more of a feeling for what the subject is," she asked, "Now, how do you explain that?" Debbie continued to ask questions about district assessments, time, and how students organize what they learn. She began to change the game--"do what I know is right and be a risk taker," she said. She determined she would take the time she needed to cover more than just "trivial waste" and asked, " . . . am I teaching the right thing?"

Throughout the staff development project, Debbie focused on "concepts," a key construct guiding the development of the teaching strategies she learned and examined in the model discussions and supplementary readings. In the process of changing, Debbie assimilated her understanding of "concept," representing her iterations of the idea throughout the project. In February, "concepts" were what she taught, like "diffusion" and "electromagnets." Even though "students don't really have a handle on them," she said early in the study, "we do need more concepts (in science)." In April, "concepts" were "trivial pursuits knowledge" in the science curriculum, where "Everything is at a pretty concrete level," Debbie said. She talked about the complexity and abstraction of concepts, notions that framed the development of the teaching strategies she practiced. By May, she explained "concepts" as fitting into a "logical picture" that students construct by organizing what they know with the teacher's help. A year after the project began, Debbie continued her study of concepts by enrolling in a course called "Cognition, Learning, and Instruction," she reported when asked to review the findings of this study. "I was really intrigued by 'concepts and schemata,'" she said, noting that the findings did not address her new understanding. Perhaps, her constructing a "concept" schemata formed a belief system that substantiated Debbie's proposed changes in practice.

When the researcher explained the findings expressed in this paper, Debbie said she agreed with the differences in her thinking about her role in the teaching process and with her having core beliefs related to science teaching that define students' learning as doing and interacting about what is done. Further, she said she takes more time to be "a better teacher. It reminded me that I need to listen to what (students) are saying . . . what prior knowledge they have . . . what connections they make." Debbie thinks about the "whole idea of schemata and building a structure . . . to hang things on . . . every day," she said.

"I'm turning into being more like the kids instead of like the teacher," Debbie said. The game changed. Ten months after the project ended, Debbie continued planning with the district's science teachers, deciding *how* and *what* to teach. As the teachers skipped from topic to topic without making connections among concepts previously studied, activities students had done, and/or students' prior knowledge, Debbie reported she asked, "How does that make sense?"

Unlike the subjects upon whom Guskey (1986) based his findings that changes in beliefs follow changes in practice, in the process of changing, Debbie discussed ongoing interactions with *what* she learned and *how* she might teach differently. Throughout and long after this study, Debbie was constructing new understandings of "concepts," "teaching," and "learning." Debbie personified the beliefs which framed this interventions--that knowledge is contructed within the individual and that meaning is socially constructed.

Implications

This research study addressed questions about the process of changing (Fullan, 1985). The findings indicate that changing practice and changing beliefs occur throughout the staff development process and that these changes represent interactive processes rather than causal ones, as suggested by Guskey (1985, 1986) and Fullan (1982, 1985). Distinguishing Debbie's changes in practice and changes in beliefs as ends of each other misinterprets the iterative process through which Debbie made sense of the learned strategies and concepts. As she engaged in learning by reading about, reflecting upon, discussing, practicing, and analyzing new practices and ideas, Debbie seemed to experience praxis--a synergistic change in both beliefs and practice. Therefore, this study raises important questions about the nature and content of staff development projects and about the methodology necessary to identify and change core beliefs.

This close look at the process of changing provides evidence of the need for constructivist research designs (Magoon, 1977) and for constructivist staff development projects that address the teacher as a learner and that involve the teacher in praxis--doing, reflecting, learning, changing. As constructivist notions about students' making sense in classroom settings impacts instruction, similarly, teachers' sense making must be considered in the design of staff development. Those projects that focus on the implementation of procedures (the *how*) but not on the beliefs that support the design and implementation of these procedures (the *what*) may always result in mutual adaptations, whether they are desirable or not; however, as Sigel (1985) suggests, the chances of changing beliefs are increased when the individual trusts the new evidence provided and the structure of the belief system is permeable. If core beliefs are indoctrinated throughout teachers' careers in schooling, staff development projects must include rich evidential arguments that challenge participant's beliefs (Green, 1976; Howard, 1987; Nisbett & Ross, 1980) and provide a variety of practices for participants' to analyze (Richardson & Anders, 1990). As Sigel (1985) and Howard (1987) explained, changing beliefs involves providing repeated evidence to change or complete the invalid belief structure. This is complementary to Fenstermacher (1986) and Green's (1976) proposition that to change practice, one must change or complete the teacher's or student's practical argument and to Richardson and Ander's (1990) findings about how teachers change beliefs and practice through staff development that includes research and practices as the content.

For research to impact practice, an iminent goal of many staff development projects (Everston, 1987; Fenstermacher, 1986, 1987, 1988; Richardson & Anders, 1990; Richardson-Koehler & Fenstermacher, 1988; Richardson-Koehler, 1987), questions about the interactive nature of beliefs and practice and how they change will continue to be raised. Methods for identifying and analyzing core beliefs--those held most strongly and those most difficult to change--may assist researchers in more carefully examining these beliefs throughout the process of changing. Further, examining the constructivist nature of learning and changing can inform the development of successful staff development projects in which teachers are empowered by their own sense-making.

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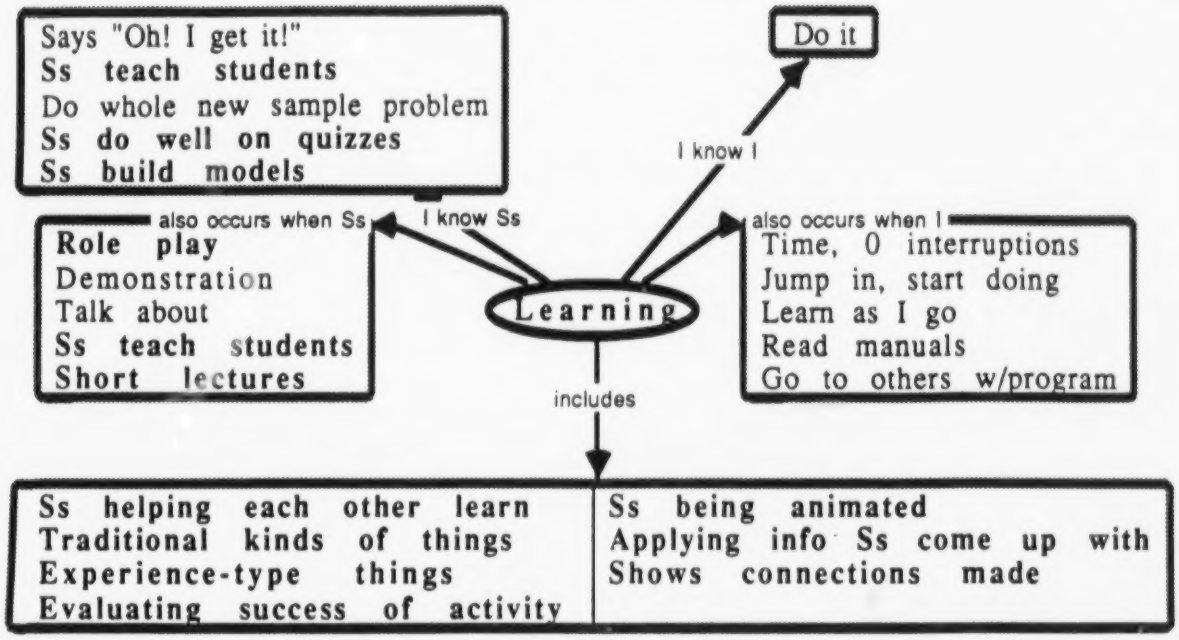

Figure 1. Central semantic map of Debbie's first interview.

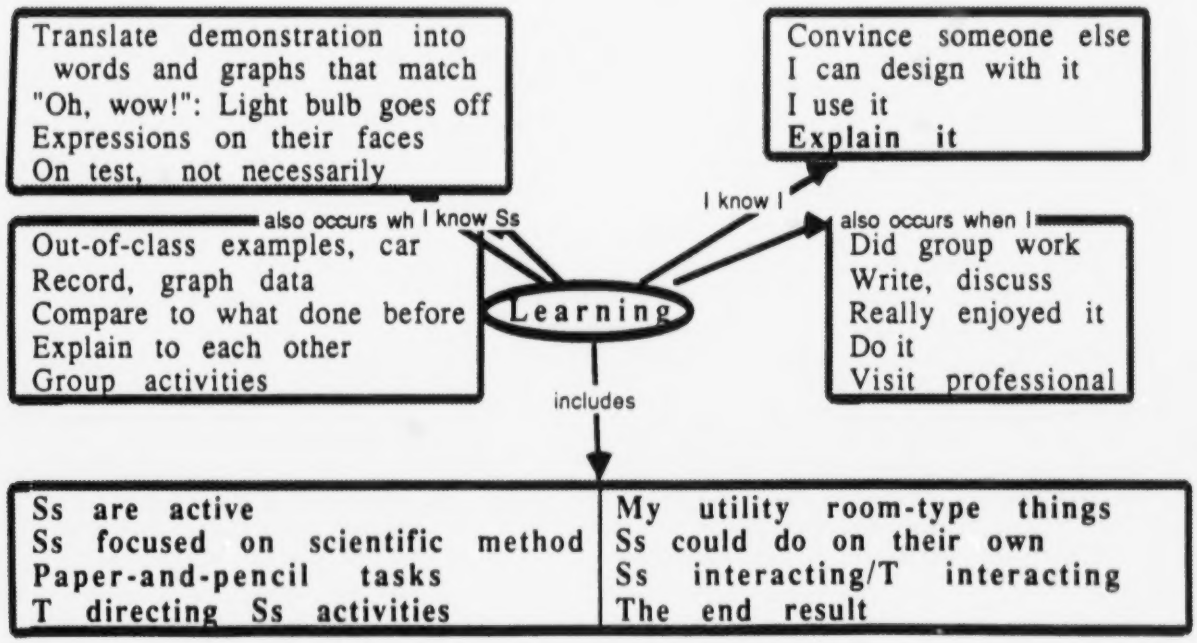

Figure 2. Central semantic map of Debbie's last interview.

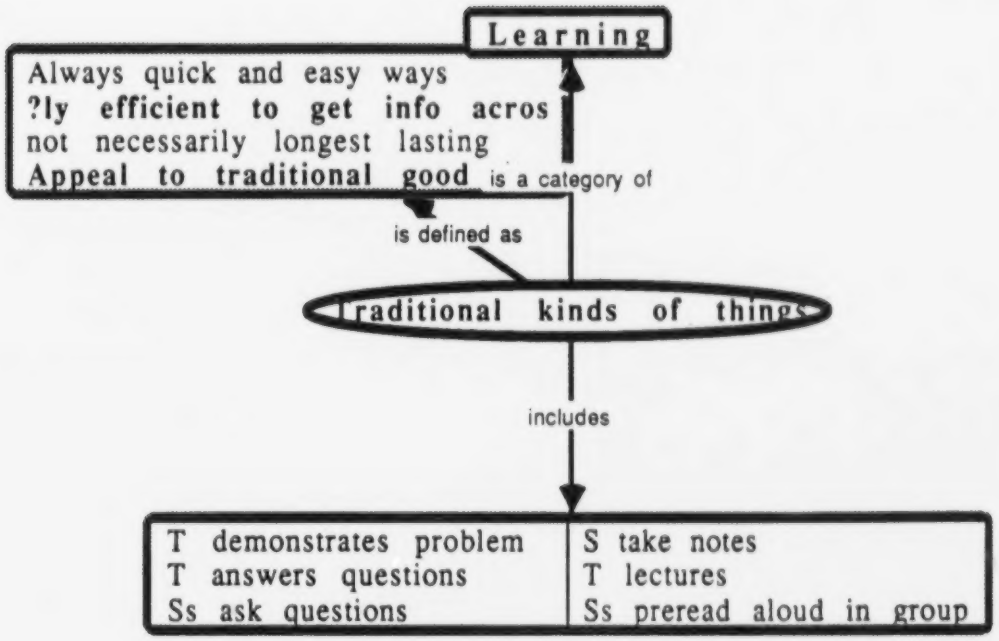

Figure 3. Example of extrapolation of semantic map.

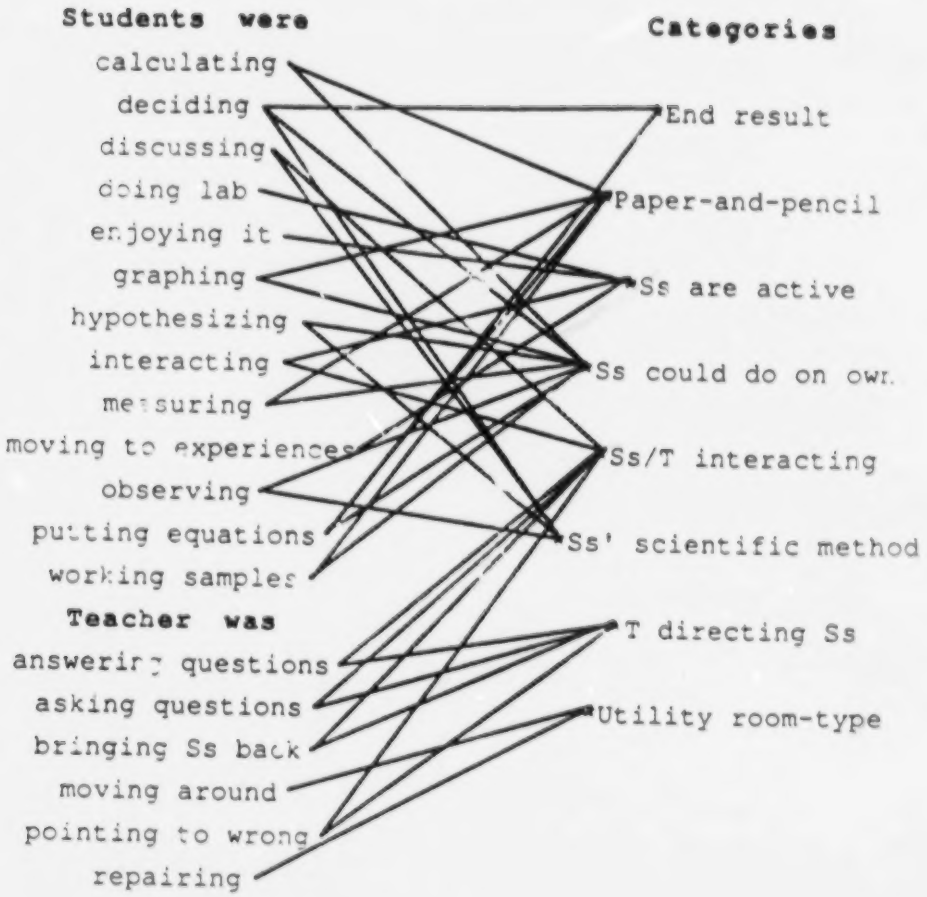

Figure 5. Outline of activities and categories Debbie named in her last interview.

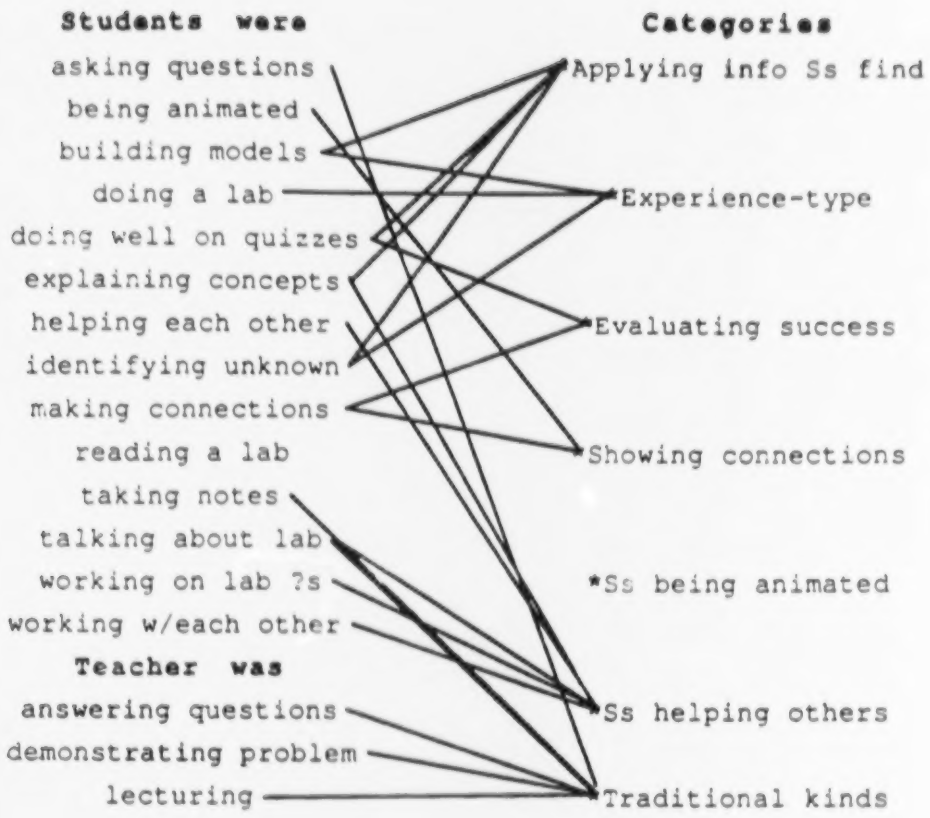

Figure 4. Outline of activities and categories Debbie named in her first interview.